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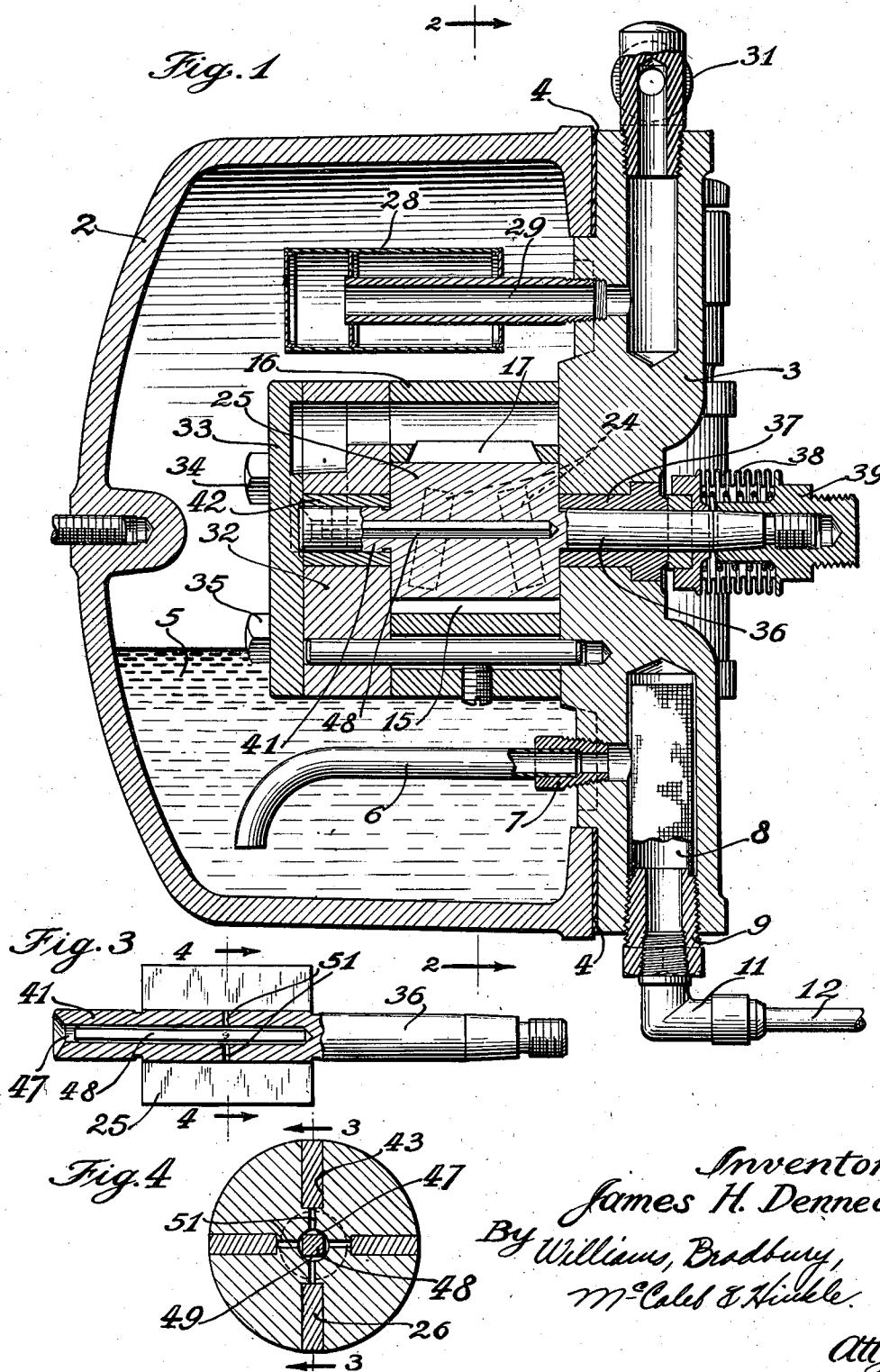
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ROTARY COMPRESSOR

Filed June 24, 1931

2 Sheets-Sheet 1



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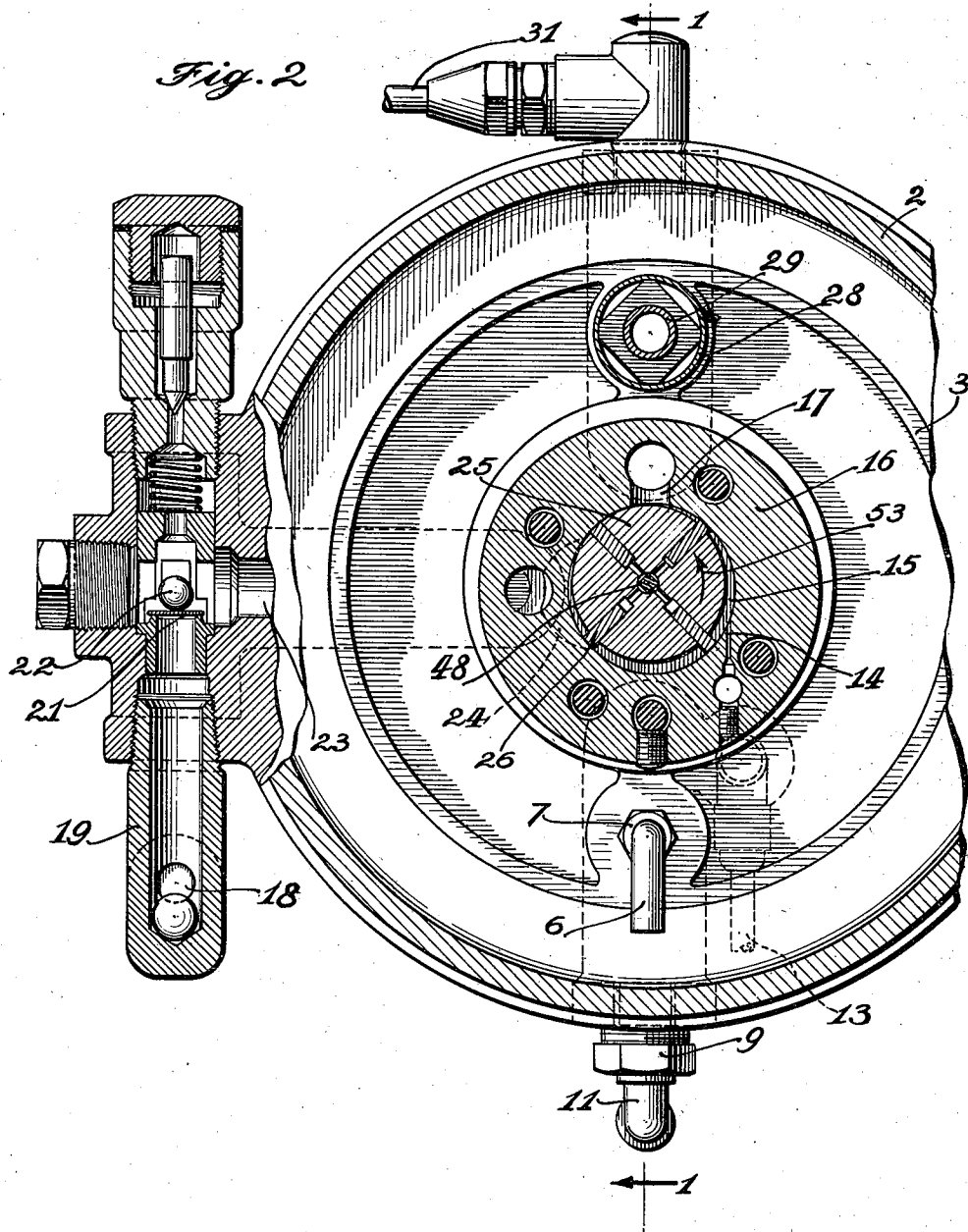
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UNITED STATES PATENT OFFICE

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ROTARY COMPRESSOR

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12 Claims. (Cl. 230—152)

This invention relates to a rotary compressor and will be described as incorporated in a refrigerating system for the compressing of refrigerant gas.

5 An object of this invention is the provision of such a compressor which will operate quietly and smoothly and with the consumption of a minimum amount of power.

10 In the prior constructions of rotary compressors using radially extending vanes slidably mounted in slots in the rotor and adapted to be pressed against the wall of the stator or casing by centrifugal force, there has been a very objectionable chattering of the vanes and a lag in the
15 movement of the vanes outwardly to their extreme outer position because of the tendency for a vacuum to be created in the slots behind the vanes. Such difficulties and objectionable operation are undesirable, not only for the reason of noise and vibration, but because of the decided reduction in efficiency caused by the escape of fluid backwardly by the vanes. This also results in the necessity of using greater power to drive the compressor for overcoming additional friction and it results in a very great reduction in the
20 compressing capacity of a compressor of predetermined dimensions and speed of rotation.

25 In rotary compressors of the type herein set forth, various mechanical devices have been employed to force the vanes outwardly such, for instance, as springs or pins extending between opposite vanes. Such mechanical devices have been found in actual practice to be noisy and inefficient. The vanes in such compressors must be
30 closely fitted to the slots in order to prevent leakage. When a close fitting vane is placed in a slot, and particularly so when an abundance of oil is present as in rotary compressors, there is a tendency upon rotation of the vanes for the vanes to
35 move outwardly under centrifugal force but in so moving the vane creates a vacuum in the bottom of the slot. I have found in practice that this vacuum is sufficient to overcome the centrifugal force and prevent the vane from moving outwardly and for this reason pins or springs have been used to push the vanes outwardly.

40 When the vanes are resting on the bottoms of the slots, and pins or springs are not employed, there are no spaces under the vanes and the slightest movement of the vanes outwardly creates a very high vacuum. I have overcome this objection by employing space behind the vanes so that slight movement outwardly will not create a high vacuum but will at most only reduce
45 the pressure in such space. A direct vent from

one slot to the opposite slot causes noise and decreases the efficiency of the compressor. I have overcome this difficulty by the use of high resistance passageways connecting the various slots, as will be hereinafter more particularly described. 5

It is the object of my invention to provide an improved compressor which overcomes the foregoing objections.

Other objects and advantages of my improved construction will appear from the following description. 10

In the accompanying drawings,

Fig. 1 is a vertical longitudinal section taken through a refrigerating unit and compressor incorporating my invention and more particularly
15 taken on substantially the line 1—1 of Fig. 2;

Fig. 2 is a vertical section taken partially on the line 2—2 of Fig. 1 and partially offset into the plane of the intake port;

Fig. 3 is a longitudinal section through the
20 rotor, taken on the line 3—3 of Fig. 4, with the compressor vanes omitted and showing a portion of the rotor in elevation; and

Fig. 4 is a vertical section taken on the line 4—4 of Fig. 3 and showing the compressor vanes in
25 position and in section.

My improved compressor is illustrated in the drawings as incorporated in a refrigerating unit comprising a casing 2 having an open end which is normally closed by a casting 3. A suitable
30 gasket 4 is interposed between the casing 2 and the casting 3 to form a fluid-tight seal to prevent the escape of gas and oil from the interior of the casing. The casing is normally partly filled with oil 5 to substantially the level indicated in Fig. 1. 35 The oil is adapted to pass out of the casing through a discharge line including a conduit 6, a fitting 7, a bore 8 in the casting 3, a fitting 9, an elbow 11, and a conduit 12. Oil is normally introduced into the casing 2 through a conduit 40 13 and associated conducting elements terminating in a duct 14 which discharges into the space 15 within the compressor casing or stator 16. The oil is discharged from the compressor through the discharge conduit 17 directly into the casing 45 2 which normally contains refrigerant under high pressure.

Low pressure refrigerant is admitted to the compressor through a conduit 18, upwardly through a fitting 19, past the check valve 21 comprising a wafer and a ball 22 held on the wafer by gravity, and through a passageway 23, and opening into a plurality of relatively wide-mouthed inlet ports 24 to the space between the rotor 25 and the compressor casing. The refrigerant 55

erant is compressed by the vanes 26 and discharged through the discharge port 17 directly into the casing 2 from which it passes through the separator 28 and outwardly through the discharge portion 29 thereof and through the discharge conduit 31 for use in a refrigerator not illustrated.

The compressor consists of a cylindrical stator or casing 16 which is open at both ends and when assembled is normally closed at one end by engagement with the inner surface of the casting 3 and at the other end by engagement with a casting 32 having a cover plate 33 thereon and firmly held in position by the bolts 34 and 35 which pass directly through the compressor casing for holding the same upon the face of the casting 3. The rotor 25 preferably consists of a single cylindrical element which has a reduced portion 36 at one end journaled in a bearing 37 and passing through the same. The extreme outer end of the portion 36 is provided with a fluid seal 38 and a nut 39 which is adapted to receive driving force from any suitable source of power. The other end of the rotor 25 is provided with a reduced portion 41 journaled in a bearing 42 in the member 32. The end of the bearing 42 is sealed by the cover plate 33 to prevent the passage of fluid between the interior of the casing and the interior of the compressor through the bearing 42.

The rotor is provided with a plurality of slots 43 which preferably extend longitudinally parallel with the axis of the rotor and which also extend radially from the surface of the rotor to a point inwardly thereof which, however, leaves sufficient material beneath the bottom of the slot 43 to provide strength to overcome the centrifugal force to which the rotor is subjected in operation. From the reduced portion 41 of the rotor backwardly through the body of the rotor is provided a substantially cylindrical bore 47 passing along the axis of the rotor. The bore 47 is preferably cylindrical and is provided with a pin 48, which pin is preferably a prism and in the drawings is shown to be square in cross-section. The corners of the pin 48 very tightly engage the surface of the passageway 47 in a manner such that the pin 48 is very snugly circumscribed by the passageway 47 to provide a plurality of passages 49, one along each flat side of the pin 48. The inner end of the pin 48 is tightly pressed against the bottom of the bore forming the passageway 47 to prevent the passage of fluid from one of the passages 49 to the others at the inner end thereof. The outer end of the pin 48 does not extend to the outer end of the passageway 47 but leaves a portion through which intercommunication is permitted between the passages 49. Each of the passages 49 communicates with the slots 43 below the vanes 26 through radially extending ducts 51. The ducts 51 are preferably relatively small in cross-section to form a resistance to the passage of fluid therethrough.

This construction places each slot into communication with the other slots by means of a passage having a high frictioned resistance, but at the same time permits the outward movement of the vanes from causing a vacuum to be formed behind the vanes which would restrain outward movement.

In the operation of my compressor, gas is admitted through the inlet ports 24 and carried by the rotor between its vanes while being compressed around to the discharge bore 17. It leads out of the compressor proper into the compression chamber formed by the casing 2. The re-

serve 5 of lubricating oil in the bottom of the casing 2 is thus subjected to the high or discharge side pressure. This being somewhat higher than the pressure in the compressor between the oil duct 14 and the discharge port 17, oil will be caused to flow through the conduits 6, 12, 13, and 14 into the compressor through the duct 14. The arcuate spaces between the vanes of the compressor are subjected to increasingly high pressure as the space approaches the discharge port in rotation. This subjects the oil which has been injected into the space to an increasing pressure tending gradually to seep or work its way between the blade and slot into the passages which interconnect the slots. If any refrigerant has found its way into these passages, the oil will thus displace it.

I do not, however, employ a lubricant feed to the slot interconnecting passages, in the sense that the term "feed" is usually applied. Any flow of the oil from the compressor casing into the passages within the rotors is a very gradual seepage and, as it will be observed, not one which subjects the passages to any prevailing liquid pressure from without. In the specific instance of the four vanes here shown, the sum of the displacements per degree of rotation for the two in-moving vanes is the same as that for the two out-moving vanes, and this is true for most vane type compressors. The hydraulic interconnection of the vane slots by the oil passages in the rotor constitutes virtually a closed hydraulic transmission system having a constant volume. This constant volume is maintained, because, as explained, as certain of the blades move in, the others correspondingly move out. Ordinarily centrifugal force will cause the blades to move outwardly in their slots and the camming action of the eccentric mounting will push them in again. When there is no sticking of the vanes, the lubricant will surge back and forth through the slot-interconnecting passages with comparatively slight pressure. There is comparatively little danger of a vane sticking when it should move inwardly, for the camming action of the slidably eccentric mounting of the rotor in the casing is so powerful. But if a vane were to stick in its innermost position when it should move out under centrifugal force, then the two vanes which happen to be moving in at the moment will build up pressure under the powerful force of the camming action against the in-moving vanes. A very high pressure will then be built up almost instantaneously and much faster than it can be relieved by any leakage between the vanes and the slots. Thus if a vane sticks, a pressure will automatically be built up to whatever force is necessary to move the vane. But such a pressure will not be built up unless a vane does stick, and the pressure will be built up only to the amount required to make the sticking vane move. A "closed" hydraulic interconnection of the vanes has greater advantage over a liquid interconnection of the vanes which might be described as an "open" or "feed" system where, for instance, the end of the center bore of the rotor is freely connected with a conduit leading from the oil reserve 5. In the latter case each vane would always be subject to a continuous hydraulic pressure, thereby putting unnecessary wear on the outer edge of the vane and on the bore of the compressor. If a vane were to stick, it would then be impossible to build up any additional pressure to relieve it, for any additional pressure developed by the in-moving vanes would merely back up against the feed

pressure. It would therefore be impossible to use hydraulic pressure for relieving a sticking vane at any higher pressure than the feed pressure. If the constant feed pressure were to be increased to a point where it was calculated to relieve most of the danger of sticking vanes, it would be at the expense of greater wear due to friction and greater operating expense due to additional power required to satisfy the additional heat of friction.

There is also an advantage in having each vane hydraulically interconnected with all of the other vanes rather than being connected merely with its opposite vane. One advantage is that the burden of building up pressure necessary to move a sticking vane is distributed between two in-moving vanes instead of being concentrated upon only one in-moving vane. This makes for better wear and less vibration in the event that a chronically sticking vane develops.

There is also considerable advantage in the use of the long restricted passages afforded by the faces of the prismatic pin 48 in interconnecting the vane slots, although I contemplate that my compressor will operate satisfactorily in many cases—especially where quiet operation is not so essential—without any pin 48 in the axial bore of the rotor. The reason that the long restricted liquid passages interconnecting the slots is of advantage is this: In the rotation of the rotor, each vane at one point passes over and momentarily closes off the oil feed duct 13. The oil in this passage is under considerable pressure. At the instant the duct 14 is closed by the edge of a vane, the oil in the duct, partly because of its prevailing pressure and partly because of a hydraulic ram-like action, tends very abruptly to push—almost knock—the vane inwardly. If the inner end of the vane were too freely hydraulically interconnected with the other vanes, it would transmit a momentary vibration to them, increasing the friction of their outer edges against the bore of the casing. For this reason and perhaps other reasons, a condition best described as “chattering” develops. I have found that if the vane slots are not too freely interconnected but only through long and restricted passages, a sufficient fluid resistance is built up in the passages to cushion the knock, with the result that the chattering is avoided. A prism having as many faces as there are blades, inserted in an axial bore of the rotor with its longitudinal edges sealed against the bore provides a peculiarly simple, economical and convenient expedient for effecting such a connection.

If the ducts interconnecting the vane slots were of large flow capacity, when a given slot came into the high pressure arc of its revolution, the high pressure would expel some of the lubricant along the working passages between the vanes and their slots (which result from the inherently somewhat loose fit in which the lubricant is normally intended to seal) toward the corresponding working clearance of the opposite vane in the low pressure arc. As a result a considerable quantity of lubricant would be expelled into the chambers adjoining that opposite slot. The amount of this leakage would, of course, increase with the age of the compressor and the attendant wear increasing the clearance between the vanes and the slots. The objection to such introduction of lubricant into the compartments at the low pressure or inlet arcs is that to the extent the compartments or chambers between the blades are filled with lubricant the capacity for gas is reduced.

The restriction which I place in the passages

interconnecting the slots reduces the effective flow capacity between slots to a restricted flow much less than that permitted by the clearance between the vanes and the slots. Consequently the lubricant leakage between the high pressure region and the low pressure region through the rotor is so materially reduced by my restricted passages that the lessening of the gas capacity of the compressor is reduced to a harmless minimum.

It will be understood that the term “restriction” as applied to the passage means herein, is used in the sense analogous to resistance as distinguished from conductivity in electrical circuits and refers to a passage in which the restriction of the passage rather than free or ready conduction is the predominating characteristic. Somewhat similarly, in referring to the restricted passages in the rotor being considerably longer than the distance between the slots, I mean a character of passageway in which the passageway is greatly elongated over that which would otherwise be employed in providing a free and ready conduction of liquid between the slots; that is, where the additional length is provided for the purpose of restricting communication.

From the foregoing description it will be readily appreciated that certain changes and modifications can be made in this improved compressor without departing from the principle of my invention, and I therefore desire to avail myself of any such modifications as come within the scope of the appended claims:

I claim:

1. In a fluid compressor, in combination, a cylindrical casing, a cylindrical rotor in said casing, said rotor being journaled on its axis eccentrically of the axis of the casing, intake and discharge ports in said casing, said rotor having a plurality of longitudinally extending slots therein, compressor vanes slidably fitted in said slots for sweeping the inner surface of the casing when rotated, said rotor having a longitudinally extending passageway and ducts connecting the slots with the passageway, and a prism-shaped element circumscribed by the surface of the passageway forming a plurality of interconnected passages for resisting the passage of fluid therethrough.

2. In a rotary compressor, in combination, a cylindrical casing having intake and discharge ports, and having a lubricant feed duct in its circumferential wall, a cylindrical rotor of smaller diameter than said casing journaled parallel with the axis of the casing to engage the circumferential wall thereof, said rotor having longitudinal slots, slidably mounted vanes in the slots adapted to slidably engage the inner surface of the casing when rotated, said rotor having a longitudinally extending passageway and ducts connecting the slots with the passageways, and a prism-shaped element circumscribed by the surface of the passageway, thereby forming a plurality of interconnected passages for resisting the passage of fluid therethrough.

3. In a rotary compressor, in combination, a cylindrical casing having intake and discharge ports, and having a lubricant feed duct in its circumferential wall, a cylindrical rotor of smaller diameter than said casing journaled parallel with the axis of the casing to engage the circumferential wall thereof, said rotor having longitudinal slots, slidably mounted vanes in the slots adapted to slidably engage the inner surface of the casing when rotated, said rotor having a longitudinally extending passageway and ducts connecting the

slots with the passageways, and a pin in said passageway engaging the inner surface thereof along parallel lines, and spaced therefrom at intermediate points to form a plurality of interconnected restricted passages communicating with said ducts.

4. In a rotary fluid compressor, in combination, a casing having a cylindrical inner surface, said casing having intake and discharge ports and an oil feed duct spaced circumferentially from said ports, a cylindrical rotor of smaller diameter than the casing and of a length to snugly fit therein, said rotor being journaled on its axis parallel with the axis of the casing and engaging the circumferential inner surface of the casing between the discharge and intake ports, said rotor having radial slots extending longitudinally thereof, compressor vanes slidably fitted in said slots and adapted to be urged against the casing by centrifugal force and sweep the same when the rotor is rotated, said rotor having a cylindrical passageway extending longitudinally thereof, a non-cylindrical pin shorter than the passageway tightly fitted in the passageway and having uninterrupted contact with the surface of the passageway along a plurality of parallel lines, thereby forming restricted passages along the sides of the pin, and ducts leading from the passages to the bottoms of the slots.

5. In a rotary fluid compressor, in combination, a casing having a cylindrical inner surface, said casing having intake and discharge ports and an oil feed duct spaced circumferentially from said ports, a cylindrical rotor of smaller diameter than the casing and of a length to snugly fit therein, said rotor being journaled on its axis parallel with the axis of the casing and engaging the circumferential inner surface of the casing between the discharge and intake ports, said rotor having radial slots extending longitudinally thereof, compressor vanes slidably fitted in said slots and adapted to be urged against the casing by centrifugal force and sweep the same when the rotor is rotated, said rotor having a cylindrical passageway extending along its axis and closed at one end, a square pin tightly circumscribed by the surface of the passageway and tightly pressed against the body of the rotor at the closed end of the passageway, thereby forming a plurality of small passages along the sides of the pin, said pin being shorter than the passageway to permit intercommunication of the passages at one end of the pin, means for preventing the escape of fluid from the end of the passageway, and ducts in the rotor providing communication between the bottom of each slot and a corresponding passage along said pin.

6. A gas compressor comprising a body having a cylindrical bore, a rotor eccentrically journaled within the bore, radial slots in the rotor, means forming arcuately offset inlet and discharge ports for the gas, vanes radially slidable in the slots, an inlet port for liquid lubricant under high pressure communicating with the bore and swept by the outer edges of the vanes, an axial system of elongated restricted passages each connected to a slot inwardly of the vane said passages intercommunicating at one end confining lubricant and providing restricted paths for said lubricant whereby the impact given the outer edge of one vane in passing said lubricant port is dampened in hydraulic communication through said passages to another vane.

7. A gas compressor comprising a body having a cylindrical bore, a rotor eccentrically journaled

within the bore, radial slots in the rotor, means forming arcuately offset inlet and discharge ports for the gas, vanes radially slidable in the slots, an inlet port for liquid lubricant under high pressure communicating with the bore and swept by the outer edges of the vanes, liquid lubricant filled passage means interconnecting the slots inwardly of the vanes and confining the lubricant communication therebetween to restricted paths whereby the impact given the outer edge of one vane in passing said lubricant port is dampened in hydraulic communication through said paths to another vane, said passage means comprising an axial longitudinally extending passage in the rotor included in said path.

8. A compressor rotor having a plurality of longitudinally extending radial slots, vanes radially slidable therein, a cylindrical bore extending axially of the rotor and ducts communicating between the respective slots, inwardly of their vanes, with the bore through its cylindrical surface, and a prism, having as many sides as there are slots, within the bore with its edges forming fluid seals with the surface of the bores to form longitudinal passages of segmental cross section, each of the passages communicating with one of the ducts, respectively, each passage communicating with at least one other passage to confine inter-slot communication to paths along said passages.

9. A gas compressor comprising a body having a cylindrical bore, a rotor eccentrically journaled therein, means forming inlet and outlet gas passages for the compressor, radial slots in the rotor, vanes in the respective slots and slidable radially therein with the outer edges sweeping the bore of the body, a liquid lubricant inlet port leading from a source of lubricant under high pressure and communicating with the bore and swept by the outer edges of the vanes, and means affording a cushioned hydraulic communication between the inner edges of the vanes, comprising an axial bore of circular cross section in the rotor, a duct communicating between each slot and the axial bore, and a prism inserted in the bore with its edges sealing against the cylindrical surface thereof and having as many sides as there are slots, leaving longitudinal segmental passages, one of which faces each duct, and means forming a communication between the respective passages longitudinally spaced from their ducts, whereby fluid communication between each slot and another slot is confined to longitudinal paths through two of said passages, said passages and ducts being filled with liquid lubricant and constituting a closed hydraulic system.

10. In a gas compressor, in combination a cylindrical casing, a cylindrical rotor in the casing, said rotor being journaled on its axis eccentrically of the axis of the casing, intake and discharge ports in said casing, said rotor having a plurality of longitudinally extending radial slots therein, compressor vanes slidably fitted in the slots for sweeping the inner surface of the casing when rotated, and constructed and arranged to form compartments therebetween which ensnare in rotating from the inlet port to the discharge port, relatively long flow resisting liquid lubricant filled communicating passage means in the rotor between the respective slots constituting a closed liquid system confining inter-slot lubricant flow to restricted paths considerably longer than the distance between the slots.

11. A rotary gas compressor comprising a compressor casing having a bore, a rotor mounted

eccentrically in said bore, said rotor having a plurality of arcuately spaced slots and a plurality of compressor vanes mounted in the respective slots for sweeping contact with the bore of the casing, the rotor defining passages interconnecting said slots, said passages and the slots, inwardly of the vanes, constituting a closed liquid system kept filled with liquid lubricant seeping thereinto, said vanes being urged outwardly during rotation solely by centrifugal force and the pressure of said liquid system, the inward movement of one of said vanes exerting a pressure on the lubricant in said passages to aid centrifugal force in urging another of said vanes outwardly.

12. A rotary gas compressor comprising a compressor casing having a bore, a rotor mounted

eccentrically in said bore, said rotor having a plurality of arcuately spaced radial slots and a plurality of vanes radially slidable in the respective slots, arcuately spaced inlet and discharge ports in the casing, gas chambers defined between the arcuately spaced vanes ensmalling in rotating from the inlet port to the discharge port, and high resistance passageways formed in the rotor interconnecting the slots and filled with liquid lubricant constituting a closed hydraulic system, means for supplying liquid lubricant to the rotor for seepage into said system the vanes being urged radially outwardly solely by centrifugal force and the pressure of said hydraulic system.

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